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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q

A2

(11) International Publication Number: WO 98/37706

(43) International Publication Date: 27 August 1998 (27.08.98)

(21) International Application Number: PCT/US98/03259

(22) International Filing Date: 20 February 1998 (20.02.98)

(30) Priority Data:
60/038,249 21 February 1997 (21.02.97) US

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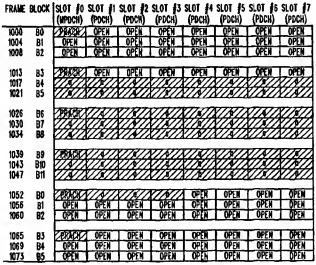
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

Without international search report and to be republished upon receipt of that report.

(54) Title: METHOD AND APPARATUS FOR ALLOCATING SPECTRAL RESOURCES IN A WIRELESS COMMUNICATION SYSTEM



(57) Abstract

The present invention encompasses a method and apparatus for efficiently communicating complex resource allocations from a central access point or base unit (14) to a mobile unit (10) requesting service. The base unit (14) allocates these resources amongst several competing mobile units (10–12) performing a variety of applications. As such, it is often desirable to generate a complex schedule to achieve the optimum assignment providing the highest quality of service to mobile units (10–12). By communicating the complex schedule of uplink resources in one downlink transfer, the mobile unit (10) is free to transmit its data on the uplink without simultaneously receiving the downlink, reducing its complexity significantly.

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METHOD AND APPARATUS FOR ALLOCATING SPECTRAL RESOURCES IN A WIRELESS COMMUNICATION SYSTEM

FIELD OF THE INVENTION

The present invention relates generally to communication systems and, in particular, to a method and apparatus for allocating spectral resources in a wireless communication system.

BACKGROUND OF THE INVENTION

Communication systems are known to comprise a plurality of mobile units (such as 8-slot half-duplex terminals) that communicate information to base units (or network) via radio frequency channels. One such communication system is a two-way radio telephone communication system. In a two-way radio telephone communication system, the mobile units are roaming transceivers that are contained in a bounded geographic region called a cell where all communication is provided through a single base unit containing a transceiver connected to a fixed wired infrastructure. Most systems will pair radio frequencies into channels to provide full-duplex communication in a technique called Frequency Division Duplexing (FDD). A mobile unit's transceiver will use one radio frequency to transmit all outgoing information to the base unit, called the uplink, while using the other radio frequency, called the downlink, to receive all incoming information. It is the base unit's responsibility to allocate these radio resources to the mobile units within it's cell and handle all competing requests appropriately.

Many radio-telephone communication systems further employ a technique of multiplexing mobile units called Time Division Multiple Access (TDMA) where the resources on one particular radio channel are divided in time and shared amongst the active mobile units. Typically resources are quantized into fixed bursts of equivalent duration (approximately 600 microseconds). These bursts are then

grouped in frames of multiple bursts (8) and a series of bursts in consecutive frames is referred to as a timeslot. Generally, for circuit switch applications such as voice, the base unit will assign a radio channel timeslot on both the uplink and downlink for service. Often, the uplink and downlink frames are staggered in time so that a mobile unit does not have to transmit and receive a burst simultaneously, greatly simplifying the radio design. A mobile unit will typically occupy a timeslot pair for a time period (3 minutes) continuously utilizing 72,000 individual bursts. The resource assignment phase will generally take a much shorter time period (1 second) and only utilize about 5 non-contiguous bursts.

For signaling conveniences, several consecutive bursts within a timeslot may be aggregated into other structures. For example, in the Groupe Special Mobile (GSM) digital cellular system for Europe, 4 consecutive bursts on a timeslot can be grouped into a block, a quantum unit to which error correction coding is applied. Furthermore, it is convenient to allocate resources based on this block boundary.

Packet data communications protocols have been defined to overlay these FDD/TDMA radio-telephone communication systems. The duration of resource allocation for a packet data communication (250 bursts) is far smaller than the traditional circuit switched call and is always unidirectional requiring bursts to be transmitted on only the uplink or downlink. Furthermore, data recovery schemes often require that a brief transmission of one block (4 bursts), called an acknowledgment, be sent on the reciprocal link (i.e. uplink if the packet was sent on the downlink) indicating which bursts were received in error. Generally speaking, these packets are generated at random intervals and multiple mobile units may request service simultaneously or while other mobile units are currently transmitting packets. In certain circumstances, it is desirable to preempt a mobile unit which is actively transmitting and assign those resources to another. For example, mobile units may be prioritized based on the requested quality of service, defined by access time and data rate, such that preemption is necessary to guarantee the promised service.

Traditionally reservation-based packet systems, as are commonly applied to the system described, will make a resource assignment of contiguous sets of bursts by specifying the starting frame, ending frame, and particular timeslots in one single resource assignment message. In fact, Nortel has proposed this scheme for GSM's General Packet Radio Service (GPRS) in Tdoc GPRS SMG2 99/96. In such a system, all supplementary traffic such as downlink acknowledgments, must be transmitted between uplink packets and would be required to wait until a uplink packet is finished. On a loaded system, the infrequent transmission of downlink acknowledgments will often double or triple the time it takes to transmit a downlink packet with most of the time wasted waiting to transmit acknowledgments.

A more flexible approach to resource assignments reserves part of a downlink block, called the User State Flag (USF), to identify the status of the corresponding uplink block. This method is what is proposed by the current GSM GPRS specification, GSM 03.64 and Version 1.1.0 The USF provides a great deal of flexibility allowing the base unit to distribute resource assignments as necessary providing room for acknowledgments with the option of preemption. However, there is a significant cost associated with this scheme. It requires that the mobile unit continuously monitor the downlink timeslot. For a mobile unit that operates on only one timeslot, this is no great burden since, as mentioned earlier, frames are staggered in time and the mobile unit would not have to receive and transmit a burst at the same time. However, if the mobile unit were to request several slots, it may have to transmit and receive at the same time to properly decode the USF. Such a mobile unit would have to include a duplex filter enabling it to receive and transmit at the same time greatly increasing it's complexity.

Therefore, a need exists for a method and apparatus to communicate a complex resource assignment to these mobile units without requiring they receive and transmit simultaneously.

Brief Description of the Drawings

FIG. 1 illustrates a system;

FIG. 2 illustrates a communication call flow between mobile unit and base;

FIG. 3 illustrates typical TDMA frame structure;

FIG. 4 illustrates a typical offset between a TDMA uplink and downlink;

FIG. 5 illustrates a basic uplink resource map for a half-duplex mobile unit;

FIG. 6 illustrates an uplink resource allocation with active circuit users;

FIG. 7 illustrates the format of a representative resource assignment message related to the resource allocation of FIG. 6;

FIG. 8 illustrates an uplink resource allocation with an active user in the presence of circuit switched users;

FIG. 9 illustrates the format of a representative resource assignment message related to the resource allocation of FIG. 8;

FIG. 10 illustrates the format of a representative resource assignment message used to preempt the user allocation shown in FIG. 21;

FIG. 11 illustrates an uplink resource allocation with an active user after preemption by another user using the message of FIG. 10.

FIG. 12 illustrates an uplink resource allocation including periodic gaps with active circuit users;

FIG. 13 illustrates the format of a representative resource assignment message;

FIG. 14 is a flow chart of a method illustrating a resource allocation being requested by a mobile;

FIG. 15 is a flow chart of a method illustrating a response from the network in response to the request of FIG. 14;

FIG. 16 is a flow chart of a method illustrating a response from the network in response to the request of FIG. 14 that reserves gaps for a second terminal;

FIG. 17 is another flow chart of a method illustrating a resource allocation being requested by a mobile;

FIG. 18 is a flow chart of a method illustrating a response from the network in response to the request of FIG. 17 that reserves gaps for mobile access to a reciprocal link;

FIG. 19 is yet another flow chart of a method illustrating a resource allocation being requested by a mobile; and

FIG. 20 is a flow chart of a method illustrating a response from the network in response to the request of FIG. 19 that sends a new allocation message when the current mobile is to be re-allocated.

FIG. 21 illustrates an uplink resource allocation with an active user prior to preemption.

DESCRIPTION OF A PREFERRED EMBODIMENT

Generally, the present invention encompasses a method and apparatus for efficiently communicating complex resource allocations from a central access point or base unit to a mobile unit requesting service. The base unit is responsible for allocating these resources amongst several competing mobile units performing a variety applications. As such, it is often desirable to generate a complex schedule to achieve the optimum assignment providing the highest quality of service to mobile units. Communicating this assignment can be costly in terms of the hardware requirements placed on the mobile units. By communicating the complex schedule of uplink resources in one downlink transfer, the mobile unit is free to transmit it's data on the uplink without simultaneously receiving the downlink, reducing it's complexity significantly. This method is in contrast to the prior art, which either requires the mobile unit to be full duplex or have allocation schemes which are not as flexible.

Stated more specifically, a method of allocating a spectral resource in a wireless communication system is disclosed. The method includes the steps of transmitting a request for the spectral resource from a terminal of the wireless communication system and receiving a

reply having an allocation message for allocating the spectral resource, the allocation message comprising a bit map allocation of multiple, discontinuous blocks within a window. In the preferred embodiment, the spectral resource is comprised of a radio frequency bandwidth and the wireless communication system is a digital communication system which is comprised of at least one of a cellular communication system, wireless local loop communication system, a time division multiple access communication system, and a code division multiple access communication system. The request for the spectral resource comprises a packet channel request and the allocation message comprises a packet resource assignment message.

The bit map allocation comprises at least one gap provided for a transmission by a second terminal and at least one gap provides for at least one of a link access channel, transfer of control information, and a reciprocal link acknowledgment. The at least one gap further reserves a portion of the spectral resource to provide the terminal with access to a reciprocal link. Access to the reciprocal link is used for at least one of an acknowledgment, transfer of control information, and a reassignment message.

In the preferred embodiment, the terminal is a half-duplex terminal or a unidirectional terminal and the wireless communication system is a bi-directional communication system. A terminal (mobile unit) within the system includes a means for transmitting a request for the spectral resource from a terminal of the wireless communication system and a means for receiving a reply having an allocation message for allocating the spectral resource, the allocation message comprising a bit map allocation of multiple, discontinuous blocks within a window.

A communication system for allocating a resource is also disclosed. The communication system comprises a mobile unit for transmitting a message including information related to the multislot capability of the mobile unit and the resources desired and a base unit for receiving the message transmitted from the mobile unit and for transmitting a message to the mobile unit including the allocated resource, starting time information and a block assignment bitmap. In this embodiment, an amount of the allocated resource is based on the

information related to the multislot capability of the mobile unit and the resources desired transmitted from the mobile unit to the base-station. The message transmitted from the mobile unit further comprises a PACKET CHANNEL REQUEST message and the message transmitted from the base unit to the mobile unit further comprises a PACKET FIXED IMMEDIATE ASSIGNMENT message. The base unit transmits the PACKET FIXED IMMEDIATE ASSIGNMENT message on the same channel as the mobile unit transmits the PACKET CHANNEL REQUEST.

A method of allocating a resource to a mobile unit in a wireless communication system is also disclosed. The wireless communication system has a predetermined framing structure which includes frames and a predetermined number of timeslots within the frame. The method comprises the steps of receiving information from the mobile unit and generating block assignment information and timeslot availability information representing how a number of blocks of resources are to be allocated to the mobile unit within the predetermined framing structure based on the information received from the mobile unit and frame start information representing when the mobile unit should begin utilizing the resource. The method also includes the step of transmitting the block assignment information, timeslot availability information and frame start information to the mobile unit such that the mobile unit can utilize the allocated resources.

In this embodiment, the mobile unit further comprises a half-duplex mobile unit with multislot capability and the number of blocks of resources are variably distributed over frames within the predetermined framing structure based on whether timeslots within the predetermined framing structure are in use by other mobile units. The number of blocks of resources are also variably distributed over frames within the predetermined framing structure based on whether periodic gaps in timeslots within the predetermined framing structure are required. The periodic gaps in timeslots within the predetermined framing structure are required to allow other mobile units to use the resource or to allow a half-duplex mobile unit to receive messages or

make measurements. The block assignment information, timeslot availability information and frame start information indicate how either a receiver or a transmitter within the mobile unit is to utilize the resources. A mobile unit for use with the corresponding method includes transmitter/receiver means for transmitting and receiving signals from a base-unit and further includes a decoder for providing the mobile unit with the resource allocation from the block assignment information, timeslot availability information and the frame start information generated according to the above process.

Another method of allocating a resource to a mobile unit in a wireless communication system is also disclosed. The wireless communication system has a predetermined framing structure which includes frames and a number of timeslots within the frame. The method includes the steps of determining that a mobile unit requires an allocation of the resource based on an arrival of information destined for the mobile unit and generating block assignment information and timeslot availability information representing how a number of blocks of resources are to be allocated to the mobile unit within the predetermined framing structure based on the information received from the mobile unit and frame start information representing when the mobile unit should begin utilizing the resource. The method further includes the step of transmitting the block assignment information, timeslot availability information and frame start information to the mobile unit such that the mobile unit can utilize the allocated resources. In this embodiment, the method is performed in a network including a base unit and the information destined for the mobile unit originates from a source external to the network. Again, the mobile unit is a half-duplex mobile unit with multislot capability.

The allocation method described herein in accordance with the invention extends the MAC layer to support a new class of mobile unit first introduced in Tdoc SMG2 GPRS 183/97 at Stuttgart. As defined, this new mobile class features a low-complexity half-duplex RF layer capable of either transmitting or receiving all eight timeslots. It holds the potential for making high-performance GPRS a pervasive service

bolstering GSM's competitive edge in the global communication market.

As stated in Tdoc SMG2 GPRS 183/97, the half-duplex nature of the new mobile class precludes the use of the MAC scheme incorporating USF bits as currently defined. The current USF scheme provides an efficient and flexible means for allocating bandwidth on the uplink. However, it also requires that the mobile unit simultaneously monitor the downlink while transmitting on the uplink. The new high performance mobile class may only do one or the other.

In order to support this mobile, a set of new messages has been defined to communicate a detailed fixed uplink resource allocation to the mobile unit. The fixed allocation consists of a start frame, slot assignment (timeslot bitmap), and block assignment bitmap representing the assigned blocks per timeslot. A mobile unit receiving this allocation will be free to transmit on the uplink without monitoring the downlink for the USF. It will allow a half-duplex mobile unit to transmit a packet in a relatively short burst, providing a high quality of service in terms of frame transmission delay. Furthermore, it will be shown that this allocation scheme provides a level of flexibility equivalent to the USF bit strategy allowing for simultaneous support of the rich variety of mobile classes.

It is intended that the protocols defined herein supplement the existing protocols. Mobile classes capable of receiving downlink timeslots while transmitting should use the USF bits as directed. The protocol extensions do not alter the MAC/RLC layer for mobile units other than the new 8-slot half-duplex class. These extensions only impact the scheduler within the network which supports this new mobile class.

FIG. 1 illustrates a system. As shown in FIG. 1, multiple mobile units 10-12 communicate with a base unit 14. FIG. 2 depicts a typical call flow between a mobile unit 10 and the base unit 12. In the RESOURCE REQUEST message 16, the mobile unit 10 communicates it's capability (i.e. multislot half-duplex) and required resources. For a typical Internet Protocol packet, the resource size is generally 1500 octets

which, in the standard GPRS encoding scheme, can be conveyed in 66 blocks. The base unit 14, upon receiving this message 16, must determine the allocation with regard to other mobile units 11-12 in the system and then communicate the allocation to mobile unit 10 precisely via a RESOURCE ASSIGNMENT message 18. As stated above, in a half-duplex mobile unit 10, problems occur with such an allocation.

In the preferred embodiment, mobile units 10-12 and base unit 14 are compatible with the framing structure shown in FIG. 3 which is that of the GSM digital cellular system. As shown in FIG. 3, a frame 30 is comprised of eight (8) timeslots 32-39 as is well known in the art. As also shown in FIG. 3 (and described above), a block 40 is comprised of four (4) of the same timeslots within 4 consecutive frames, the block 40 representing a quantum unit to which error correction coding is applied. Block 40 also provides a convenient boundary in which to allocate resources. As is also well known in the art, the uplink and downlink transmissions for mobile units with full-duplex capability are typically offset by a variable amount as shown in FIG. 4.

Packet origination for 8-slot half-duplex mobile unit 10 requires a fixed allocation be defined and communicated by the scheduler during the access phase of the packet transfer. The fixed allocation allows mobile unit 10 to transmit blocks without simultaneously monitoring the USF bits on the downlink. Considering the many competing uses of the uplink - downlink acknowledgments, random access requests, circuit traffic, etc. - and the variety of mobile unit classes, a fixed allocation must be amenable to the slots and blocks that are available. In other words, an allocation will need to contain gaps to account for active single-slot mobile units currently on the system and make room for acknowledgments to packet traffic in the reverse (uplink) direction. This section defines an efficient method for communicating a detailed resource allocation to a MS.

Two new message types support the fixed allocation scheme, a PACKET FIXED IMMEDIATE ASSIGNMENT message 52 and a PACKET FIXED RESOURCE ASSIGNMENT message 56 in accordance with the invention. These messages would be used in place of the

PACKET IMMEDIATE ASSIGNMENT message and PACKET RESOURCE ASSIGNMENT message of the typical one and two phase access request as shown in FIG. 5. In the initial PACKET CHANNEL REQUEST message 50, a half-duplex mobile unit, such as mobile unit 10 (like all other mobile units) would communicate its class and desired resources to the network. Upon receiving the request, the network would recognize mobile unit 10 as an 8-slot half-duplex MS and then respond with a PACKET FIXED IMMEDIATE ASSIGNMENT instead of the typical PACKET IMMEDIATE ASSIGNMENT message. Likewise in a two phase access, the network would send the PACKET FIXED RESOURCE ASSIGNMENT in place of the typical PACKET RESOURCE ASSIGNMENT message. Notice that the network responds with a conventional PACKET IMMEDIATE ASSIGNMENT in phase one of a two phase access and, for a time, the 8-slot half-duplex mobile unit 10 operates as the simplest class of mobile station.

The fixed allocation messages would contain nearly the identical set of fields to their counterparts proposed in Tdoc SMG2 GPRS 174/97. However, the 24-bit USF values would be replaced with an 88-bit BLOCK ASSIGNMENT BITMAP specifying the blocks in the fixed allocation in accordance with the invention. Furthermore, a 11-bit frame number would be added to specify the START FRAME of the first block in the bitmap. As one skilled in the art will appreciate, the number of bits utilized to represent the BLOCK ASSIGNMENT BITMAP and the START FRAME can vary as required by the system. In combination with the TIMESLOT BITMAP, the START FRAME and BLOCK ASSIGNMENT BITMAP uniquely define an allocation. The BLOCK ASSIGNMENT BITMAP represents a window over which blocks can be allocated. The START FRAME defines the beginning of the window while the number of assigned timeslots defines the dimensions of the window. A total of 88 blocks can be allocated over any number of timeslots. One may envision the BLOCK ASSIGNMENT BITMAP as an array of blocks. If eight timeslots are assigned, the bitmap represents an 8 by 11 array of blocks. The blocks allocated to each timeslot are represented by every eighth bit. Similarly, if four timeslots are assigned, the bitmap represents a 4 by 22

array of blocks and every fourth bit represents a block from the same timeslot. With this encoding scheme, a similarly sized resource allocation can be communicated regardless of how many timeslots have been allocated to GPRS.

FIG. 6 depicts a possible uplink resource allocation in a lightly loaded system with active users in accordance with the invention. In FIG. 6, each column represents a block allocation on a particular timeslot and each row represents a new frame with time increasing from top to bottom. A block marked as "open" indicates no assignment. A block marked Packet Random Access CHannel (PRACH) indicates that designated for resource request messages. A block marked with "a" is assigned to user a.

Referring to FIG. 6, the uplink resource allocation, as known to the scheduler in the network, during one and one half packet multiframes is depicted. As stated above, each row diagram illustrates the assignment for a new frame or combination thereof and each column illustrates the activity per timeslot. The contents of each cell represent the resource assignment which needs to be communicated. In FIG. 6, all timeslots have been assigned to Packet Data CHannels (PDCHs), timeslot zero serves as the Master Packet Data CHannel (MPDCH) containing four PRACHs per multiframe, and one 8-slot half-duplex mobile unit 10 is scheduled, labeled as mobile unit a. The network communicates this allocation by specifying the start frame as 1017 in the START FRAME portion of PACKET FIXED IMMEDIATE ASSIGNMENT message 52. FIG. 7 generally depicts a representative PACKET FIXED IMMEDIATE ASSIGNMENT message 52 in accordance with the invention. As shown in FIG. 7, the TIMESLOT BITMAP (labeled in FIG. 7 as "timeslot assignment") is set to all "1s" to indicate that all timeslots are active and the appropriate bits in the BLOCK ASSIGNMENT BITMAP portion of the message 52 are set to "1" to represent an allocated block. In this example, FIG. 7 represents the bit assignments while FIG. 6 represents the interpretation of the bit assignments within the GSM framing structure.

To illustrate the flexibility of the allocation message consider a more complex example. FIG. 8 again shows the uplink resource

allocation with active users during one and one half packet multiframes. In this example only, six (6) timeslots have been allocated to PDCHs; timeslots 4 and 5 are being used by circuit switched users. The indication to the mobile that only 6 certain timeslots have been allocated is provided by the TIMESLOT BITMAP portion (FIG. 9) of the PACKET FIXED IMMEDIATE ASSIGNMENT message 52, which in this case is "11110011" to indicate timeslots 4 and 5 have not been allocated to the half-duplex mobile unit (for example, mobile unit 10). The network again communicates the starting frame to the mobile unit 10 by specifying the start frame as 1017 in the START FRAME portion of PACKET FIXED IMMEDIATE ASSIGNMENT message 52. As before, timeslot 0 is the MPDCH and mobile a is an 8-slot half-duplex mobile unit (for example, mobile unit 10). In addition, two single-slot mobile units are using the system, mobile units 11 and 12 (labeled **b** and **c** in FIG. 8). Finally, another mobile unit, labeled **d**, is acknowledging a packet being transmitted on the downlink. FIG. 9 illustrates the format of the representative PACKET FIXED IMMEDIATE ASSIGNMENT message 52 the network would transmit to mobile **a** via base unit 14 in this scenario, including the BLOCK ASSIGNMENT BITMAP portion of the message 52. The 6 columns utilized as shown in FIG. 9 represent the allocation for the 6 PDCH timeslots. Note the gaps at the beginning of timeslots 2 and 7 which are included to accommodate mobiles b and **c**. Likewise, a gap in timeslot 3 accommodates the acknowledgment transmitted by the mobile unit labeled **d** (not shown in FIG. 1). As can be seen from this example, the fixed block assignment technique is extremely flexible and provides for multiple mobile units to access the channel without contention issues and the problems associated with the prior art techniques.

Mobile Terminated Packet Transfer

Two possibilities exist for delivering packets to an 8-slot half-duplex mobile unit 10. It is conceivable that this class of mobile unit can be supported with the current message set performing a transaction that closely resembles that of an 8-slot full-duplex mobile unit. Alternatively, the network may fix the schedule of the downlink

packet in a manner similar to the uplink, allowing the mobile unit to perform other activities while not receiving.

The network may deliver downlink messages to an 8-slot half-duplex mobile unit 10 in the same way it does to an 8-slot full-duplex mobile unit provided it takes special care not to transmit blocks on the downlink when it knows the mobile unit 10 is transmitting on the uplink. Tdoc SMG2 GPRS 174/97 defines a RLC-PACKET RESOURCE ASSIGNMENT FOR DOWNLINK message containing the TFI, assigned timeslots, and channel allocation. An 8-slot half-duplex mobile unit 10 is capable of monitoring the downlink and retrieving the downlink blocks with the assigned TFI. Furthermore, it may use the USF bits in this situation to identify the block in which to transmit the ACK on the uplink. Of course, when it sends the ACK it no longer would be able to receive the downlink blocks. Therefore, the network would need to postpone sending the downlink blocks while the mobile is transmitting. In addition, no more than one consecutive block per timeslot could be assigned since the mobile unit 10 would not read the second set of USF bits. Considering all this, it is conceivable that an 8-slot half-duplex mobile unit 10 may use the conventional set of messages provided the network and MS obey the following rules:

1. The network never allocates more than one consecutive uplink block per timeslot using the USF-bit scheme for an 8-slot half-duplex MS.
2. The network never transmits a downlink block containing information destined for an 8-slot half-duplex MS which overlaps that same MS's allocated uplink block. These restricted downlink blocks include both a block containing user data and those containing USF bits for the MS. Depending on the timeslot, an allocated uplink block may preclude transmission of several downlink blocks as result of the downlink/uplink frame offset and the relative phase of the uplink and downlink blocks.

3. Whenever an 8-slot half-duplex MS decodes it's assigned USF in the downlink it must transmit exactly one block on the uplink in the allocated timeslot.

Given the allocation method described herein in accordance with the invention, these system requirements are unnecessarily burdensome. As an alternative, a fixed resource assignment message may be defined on the downlink exactly specifying which downlink blocks will contain data destined for the 8-slot half-duplex mobile unit 10. This fixed resource assignment message would also contain the allocation for the associated uplink acknowledgments. One or two acknowledgments may be necessary depending on the number of downlink blocks transmitted. The encoding of the pertinent downlink blocks can be conveyed using a START FRAME, TIMESLOT BITMAP, and BLOCK ANNOUNCEMENT BITMAP. These three fields would be analogous to their uplink counterparts described above, except that the BLOCK ANNOUNCEMENT BITMAP would specify which downlink blocks within a window are destined for the 8-slot half-duplex mobile unit 10. The START FRAME establishes the first frame in the BLOCK ANNOUNCEMENT BITMAP, while TIMESLOT BITMAP defines the dimensions of the window (i.e., which timeslots within a frame are so allocated). Furthermore, each allocated block on the uplink for acknowledgment may be conveyed by specifying a 5-bit ACKNOWLEDGEMENT FRAME OFFSET combined with a 3-bit TIMESLOT. The ACKNOWLEDGEMENT FRAME OFFSET, combined with the START FRAME, would be summed to determine the block in which to acknowledge the downlink packet. This latter scheme mimics the uplink allocation method and may provide an advantage to the mobile unit 10.

Implications for the current MAC/RLC Layer

No protocol modifications are required for other mobile units in the system. Every other class of mobile unit would continue to employ the protocol based on USF bits as currently defined. The network must reserve one USF code out of the eight (or seven) and use it to mark the

uplink status during a fixed allocation for an 8-slot half-duplex mobile unit. Regardless of the number of 8-slot half-duplex mobile units are scheduled, only one USF needs to be reserved since these mobile units rely solely on the fixed resource allocation message. Similarly, mobile units of other classes have no need to distinguish between the allocation of one 8-slot half-duplex mobile unit or another.

System issues such as quality of service, power control, timing advance, and measurement reports will be addressed in separate contributions.

Pre-emption and reassignment

GPRS and many other systems are concerned with providing a guaranteed Quality of Service (QoS) to their subscribers. QoS is measured in terms of the mean packet transfer delay a subscriber experiences for an agreed upon data-rate. To achieve QoS guarantees, GPRS assigns users different priority levels that they must transmit with each access attempt. The network must then recognize this priority and schedule the users appropriately. If a low-priority mobile is transmitting when a high-priority mobile requests service, the low-priority mobile should be preempted by the high-priority mobile. A fixed allocation, as described in this filing, could prevent the appropriate scheduling of high-priority mobiles because a half-duplex mobile can't listen while it's transmitting. If network schedules a contiguous allocation for a low-priority half-duplex mobile, that mobile cannot receive a reassignment message and as a result cannot be preempted. Figures 21, 10 and 11, illustrate a possible solution to this problem.

FIG. 21 illustrates an uplink resource allocation with an active user prior to preemption. Strategic gaps in the uplink allocation will allow the network to communicate a reassignment message to the mobile if necessary. During a gap, a low-priority mobile unit, labeled mobile unit a, will discontinue transmission and listen to the downlink. If no reassignment message arrives, then it continues with it's current assignment and resumes transmitting until the next gap. However, if the network does transmit a reassignment message, the

low-priority mobile would discontinue transmitting pending the new allocation period. At this time, a high-priority mobile, labeled mobile unit **b**, would assume the uplink and transmit it's packet. FIG. 10 illustrates the encoding of the allocation in FIG. 21 which would be received by the low-priority mobile unit **a**. FIG. 11 shows the resulting allocation after the low-priority mobile unit a in FIG. 21 has been pre-empted in accordance with the invention.

Periodic gaps

Often the scheduler in the network does not have complete knowledge of the downlink traffic. It would be difficult to exactly schedule the gaps in the uplink allocation message to accommodate the other mobiles in the system. Therefore, it would be advantageous to put periodic gaps in a mobile units' allocation to provide for future undetermined downlink traffic. FIG. 12 illustrates an uplink resource allocation including periodic gaps with active circuit users while FIG. 13 illustrates the format of a representative resource assignment message to generate the uplink resource allocation shown in FIG. 12. As shown in FIG. 12, the network has scheduled nearly one gap per frame in varying timeslots to allow for expedient downlink acknowledgments to be conveyed on the uplink as needs arise. Furthermore, alternating timeslots provides the greatest benefit to other classes of mobile units using the system. For instance, single slot mobile units (mobile units which only operate on one TDMA timeslot) would only have to wait at most 8 blocks before transmitting a downlink acknowledgment which completes the packet transfer. Similarly, multislot mobiles would be able to transmit the downlink acknowledgment immediately since a gap exists in all frames. A network which schedules periodic gaps will reduce delay in the system ultimately providing a higher quality of service to all mobile units.

FIG. 14 generally depicts a flow chart of a method which illustrates a resource allocation being requested by a mobile unit 10 with half-duplex multislot capability. The process starts at step 1400 and proceeds to step 1402 where the mobile unit 10 waits for a packet to send. The mobile unit 10 then transmits an allocation request via

PACKET CHANNEL REQUEST message 50 on an access channel at step 1404. At step 1406, mobile unit 10 receives an allocation message on the down link in the form of PACKET FIXED IMMEDIATE ASSIGNMENT message 52. Mobile unit 10 then interprets the allocation for its transmit times at step 406 based on the content of message 52, and process proceeds to step 1410 where a test is performed by mobile unit 10 to determine if a block has been allocated for transmission. If the test is positive, flow proceeds to step 1412 where a segment of information is transmitted during a block by mobile unit 10. If, however, the result of the test at block 1410 is negative, step 1412 is skipped and flow proceeds to step 1414 where a test is performed to determine whether the allocation window has been completed. If the test at step 1414 is positive, flow proceeds to step 1402 and the process is repeated. Again, however, if the test is at step 1414 is negative, the next segment of information to be transmitted is gathered at step 1416 and flow proceeds to step 1410 where the test therein is repeated.

FIG. 15 generally depicts a flow chart of a method illustrating a response from the base unit 14 within the network in response to the request as shown in FIG. 14. Starting at step 1500, flow proceeds to step 1502 where the network waits for an allocation request by mobile unit 10. At step 1504, the network determines an allocation window for mobile unit 10 and proceeds to step 1506 where a test is performed to determine if blocks are needed for other types of traffic information. If the test at step 1506 is positive, flow proceeds to step 1508 where the network inserts gaps into the allocation to accommodate the other types of traffic information. If, however, the test at step 1506 is negative, step 1508 is skipped and flow proceeds to step 1510 where the network transmits the allocation schedule to the mobile. At the end of step 1510, flow proceeds to step 1502 where the entire process as shown in FIG. 15 is repeated.

FIG. 16 generally depicts a flow chart of a method illustrating a response which reserves gaps for a second mobile unit, the response originating from the network in response to the request as shown in FIG. 14. The process starts at step 1600 and proceeds to step 1602 where the network waits for the allocation request from mobile unit 10.

When the request is received, the network determines the allocation window for mobile unit 10 at step 1604 and proceeds to step 1606 where a test is performed to determine whether another, second terminal wishes to transmit. If the test at step 1606 is positive, flow proceeds to step 1608 where the network inserts gaps into the allocation to allow the other, second terminal access to the particular communication channel. If the test at step 1606 is negative, step 1608 is skipped and flow proceeds to step 1610 where the network transmits the allocation schedule to mobile unit 10. After step 1610, flow proceeds to step 1602 where the entire process is repeated.

FIG. 17 generally depicts a flow chart of a method of illustrating a resource allocation being requested by mobile unit 110. Referring to FIG. 17, the process starts at step 1700 and proceeds to step 1702 where the mobile waits for a packet of information to transmit to the base unit 14 within the network. At step 1704, mobile unit 10 transmits an allocation request via PACKET CHANNEL REQUEST message 50 on an access channel. At step 1706, mobile unit 10 receives an allocation message (for example PACKET FIXED IMMEDIATE ASSIGNMENT message 52) on the downlink. At step 1708, mobile unit 10 interprets the allocation for its particular transmit times. Mobile unit 10 then performs a test at step 1710 to determine if a block has been allocated for transmission. If the test at step 1710 is positive, flow proceeds to step 1712 where a segment of information is transmitted during the allocated block. If the test at step 1710 is negative, mobile unit 10 receives a message on the downlink from base unit 14 at step 1714. The step subsequent to steps 1712 and 1714 is step 1716, where a test is performed to determine if the allocation window has been completed. If the test at step 1716 is positive, flow proceeds to step 1702 and the entire process is repeated. If, however, the test at step 1716 is negative, flow proceeds to step 1718 where the segment to be next transmitted is gathered. Following step 1718, flow proceeds to the test at step 1710 where the lower half of the flow depicted in FIG. 17 is repeated.

FIG. 18 generally depicts a flow chart of a method illustrating a response from the network in response to the request of FIG. 17 which reserves gaps for mobile access to a reciprocal link in accordance with

the invention. As shown in FIG. 18, flow starts at step 1800 and proceeds to step 1802 where the network waits for the allocation request from mobile unit 10. Flow proceeds to step 1804 where the network determines an allocation window from mobile unit 10. At step 1806, a test is performed to determine if blocks are needed for reciprocal link access by mobile unit 10. If the test at step 1806 is positive, the network inserts gaps into the allocation to allow mobile unit 10 occasional reciprocal link access. If the test at step 1806 is negative, however, step 1808 is skipped and flow proceeds to step 1810 where the network transmits the allocation schedule to mobile unit 10. After step 1810, flow proceeds to step 1802 where the entire flow depicted in FIG. 18 is repeated.

FIG. 19 generally depicts a flow chart of a method of illustrating a resource allocation being requested by mobile unit 110. Referring to FIG. 19, the process starts at step 1900 and proceeds to step 1902 where the mobile waits for a packet of information to transmit to the base unit 14 within the network. At step 1904, mobile unit 10 transmits an allocation request via PACKET CHANNEL REQUEST message 50 on an access channel. At step 1906, mobile unit 10 receives an allocation message (for example PACKET FIXED IMMEDIATE ASSIGNMENT message 52) on the downlink. At step 1908, mobile unit 10 interprets the allocation for its particular transmit times. Mobile unit 10 then performs a test at step 1910 to determine if a block has been allocated for transmission. If the test at step 1910 is positive, flow proceeds to step 1912 where a segment of information is transmitted during the allocated block. If the test at step 1910 is negative, mobile unit 10 receives a message on the downlink from base unit 14 at step 1914 and a test is performed at step 1916 to determine whether a message to reassign the allocation has been received. If the test at step 1916 is positive, flow proceeds to step 1908 where the mobile unit 10 again interprets the allocation for its particular transmit times. If the test at step 1916 is negative, a test is performed to determine if the allocation window has been completed at step 1918. If the test at step 1918 is positive, flow proceeds to step 1902 and the entire process is repeated. If, however, the test at step 1918 is negative, flow proceeds to step 1920

where the segment to be next transmitted is gathered. Following step 1920, flow proceeds to the test at step 1910 where the lower half of the flow depicted in FIG. 19 is repeated.

FIG. 20 generally depicts a flow chart of a method illustrating a response from the network in response to the request of FIG. 19 which sends a new allocation message when a current mobile unit 10 is to be reallocated in accordance with the invention. As shown in FIG. 20 the method starts at step 2000 and proceeds to step 2002 where the network waits for an allocation request from a mobile unit. At step 2004, the network determines the allocation window for mobile unit 10 and proceeds to step 2014 where a test is performed to determine if the allocation preempts an allocation in progress. If the test at step 2014 is positive, flow proceeds to step 2006 where the network determines a new allocation for the other mobile unit and then inserts gaps into the new allocation to accommodate higher priority traffic at step 2008. Next, at step 2010, the network inserts gaps into the new allocation to allow the other mobile unit to occasionally access the reciprocal link and at step 2012, the network transmits the new allocation schedule to the other mobile. After step 2012, and if the test at step 2014 is negative flow proceeds to step 2016 where the network inserts gaps into the new allocation to accommodate existing traffic. At step 2018, the network inserts gaps into the allocation to allow a mobile unit to occasionally access the reciprocal link. At step 2020, the network transmits the allocation schedule to the mobile and proceeds to step 2002 where the entire flow of FIG. 20 is repeated.

While the invention has been particularly shown and described with reference to a particular embodiment, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention. The corresponding structures, materials, acts and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or acts for performing the functions in combination with other claimed elements as specifically claimed.

What we claim is:

CLAIMS

1. A method of allocating a spectral resource in a wireless communication system, the method comprising the steps of:

transmitting a request for said spectral resource from a terminal of said wireless communication system; and

receiving a reply having an allocation message for allocating said spectral resource, said allocation message comprising a bit map allocation of multiple, discontinuous blocks within a window.

2. The method of claim 1 wherein said spectral resource is comprised of a radio frequency bandwidth.

3. The method of claim 1 wherein said wireless communication system is a digital communication system.

4. The method of claim 3 wherein said digital communication system is comprised of at least one of a cellular communication system, wireless local loop communication system, a time division multiple access communication system, and a code division multiple access communication system.

5. The method of claim 1 wherein said request for said spectral resource comprises a packet channel request.

6. The method of claim 1 wherein said allocation message comprises a packet resource assignment message.

7. The method of claim 1 wherein said bit map allocation comprises at least one gap provided for a transmission by a second terminal.

8. The method of claim 7 wherein said at least one gap provides for at least one of a link access channel, transfer of control information, and a reciprocal link acknowledgment.

9. The method of claim 1 wherein said at least one gap reserves a portion of said spectral resource to provide said terminal with access to a reciprocal link.

10. The method of claim 9 wherein access to said reciprocal link is used for at least one of an acknowledgment, transfer of control information, and a reassignment message.

11. The method of claim 1 wherein said terminal is a half-duplex terminal.

12. The method of claim 1 wherein said terminal is a unidirectional terminal.

13. The method of claim 1 wherein said wireless communication system is a bi-directional communication system.

14. An apparatus for allocating a spectral resource in a wireless communication system, the apparatus comprising:

means for transmitting a request for said spectral resource from a terminal of said wireless communication system; and

means for receiving a reply having an allocation message for allocating said spectral resource, said allocation message comprising a bit map allocation of multiple, discontinuous blocks within a window.

15. A communication system for allocating a resource, the communication system comprising:

a mobile unit for transmitting a message including information related to the multislot capability of the mobile unit and the resources desired; and

a base unit for receiving the message transmitted from the mobile unit and for transmitting a message to the mobile unit including the allocated resource, starting time information and a block assignment bitmap.

16. The communication system of claim 15, wherein an amount of the allocated resource is based on the information related to the multislot capability of the mobile unit and the resources desired transmitted from the mobile unit to the base-station.

17. The communication system of claim 15, wherein the message transmitted from the mobile unit further comprises a PACKET CHANNEL REQUEST message.

18. The communication system of claim 17, wherein the message transmitted from the base unit to the mobile unit further comprises a PACKET FIXED IMMEDIATE ASSIGNMENT message.

19. The communication system of claim 18, wherein the base unit transmits the PACKET FIXED IMMEDIATE ASSIGNMENT message on the same channel as the mobile unit transmits the PACKET CHANNEL REQUEST.

20. A method of allocating a resource to a mobile unit in a wireless communication system, the wireless communication system having a predetermined framing structure, the framing structure including frames and a number of timeslots within the frame, the method comprising the steps of:

receiving information from the mobile unit;

generating block assignment information and timeslot availability information representing how a number of blocks of resources are to be allocated to the mobile unit within the predetermined framing structure based on the information received from the mobile unit and frame start information representing when the mobile unit should begin utilizing the resource; and

transmitting the block assignment information, timeslot availability information and frame start information to the mobile unit such that the mobile unit can utilize the allocated resources.

21. The method of claim 20, wherein the mobile unit further comprises a half-duplex mobile unit with multislot capability.

22. The method of claim 20, wherein the number of blocks of resources are variably distributed over frames within the predetermined framing structure based on whether timeslots within the predetermined framing structure are in use by other mobile units.

23. The method of claim 20, wherein the number of blocks of resources are variably distributed over frames within the predetermined framing structure based on whether periodic gaps in timeslots within the predetermined framing structure are required.

24. The method of claim 23, wherein the periodic gaps in timeslots within the predetermined framing structure are required to allow other mobile units to use the resource or to allow a half-duplex mobile unit to receive messages or make measurements.

25. The method of claim 20, wherein the block assignment information, timeslot availability information and frame start information indicate how either a receiver or a transmitter within the mobile unit is to utilize the resources.

26. A mobile unit for use in a wireless communication system, the mobile unit comprising transmitter/receiver means for transmitting and receiving signals from a base-unit, the mobile unit further comprising a decoder for providing the mobile unit with the resource allocation from the block assignment information, timeslot availability information and the frame start information generated according to claim 20.

27. A method of allocating a resource to a mobile unit in a wireless communication system, the wireless communication system having a predetermined framing structure, the framing structure including frames and a number of timeslots within the frame, the method comprising the steps of:

determining that a mobile unit requires an allocation of the resource based on an arrival of information destined for the mobile unit;

generating block assignment information and timeslot availability information representing how a number of blocks of resources are to be allocated to the mobile unit within the predetermined framing structure based on the information received from the mobile unit and frame start information representing when the mobile unit should begin utilizing the resource; and

transmitting the block assignment information, timeslot availability information and frame start information to the mobile unit such that the mobile unit can utilize the allocated resources.

28. The method of claim 27, wherein the method is performed in a network including a base unit.

29. The method of claim 28, wherein the information destined for the mobile unit originates from a source external to the network.

30. The method of claim 27, wherein the mobile unit further comprises a half-duplex mobile unit with multislot capability.

31. The method of claim 27, wherein the number of blocks of resources are variably distributed over frames within the predetermined framing structure based on whether timeslots within the predetermined framing structure are in use by other mobile units.

32. The method of claim 27, wherein the number of blocks of resources are variably distributed over frames within the

predetermined framing structure based on whether periodic gaps in timeslots within the predetermined framing structure are required.

33. The method of claim 32, wherein the periodic gaps in timeslots within the predetermined framing structure are required to allow other mobile units to use the resource or to allow a half-duplex mobile unit to receive messages or make measurements.

34. The method of claim 27, wherein the block assignment information, timeslot availability information and frame start information indicate how a receiver within the mobile unit is to utilize the resources.

35. A mobile unit for use in a wireless communication system, the mobile unit comprising transmitter/receiver means for transmitting and receiving signals from a base-unit, the mobile unit further comprising a decoder for providing the mobile unit with the resource allocation from the block assignment information, timeslot availability information and the frame start information generated according to claim 27.

36. A method of allocating a resource to a mobile unit in a wireless communication system, the wireless communication system having a predetermined framing structure, the framing structure including frames and a number of timeslots within the frame, the method comprising the steps of:

determining that the mobile unit requires an allocation of the resource based on information received from the mobile unit;

generating block assignment information and timeslot availability information representing how a number of blocks of resources are to be allocated to the mobile unit within the predetermined framing structure based on the information received from the mobile unit and frame start information representing when the mobile unit should begin utilizing the resource; and

transmitting the block assignment information, timeslot availability information and frame start information to the mobile unit such that the mobile unit can utilize the allocated resources.

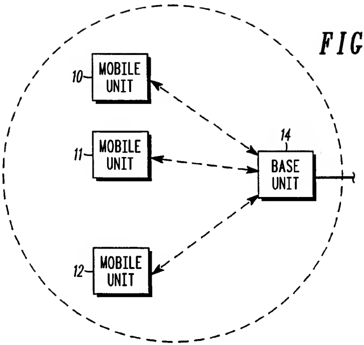
MOBILE UNIT
10
MOBILE UNIT
11
MOBILE UNIT
12
BASE UNIT
14

FIG.1

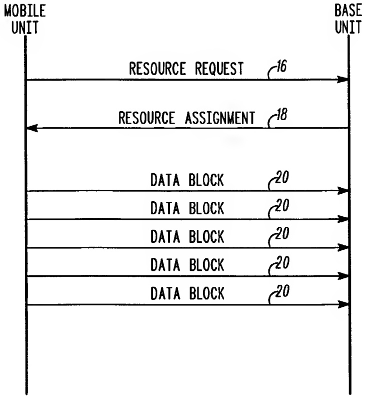
MOBILE UNIT
BASE UNIT
RESOURCE REQUEST
16
RESOURCE ASSIGNMENT
18
DATA BLOCK
20
DATA BLOCK
20
DATA BLOCK
20
DATA BLOCK
20
DATA BLOCK
20

FIG.2

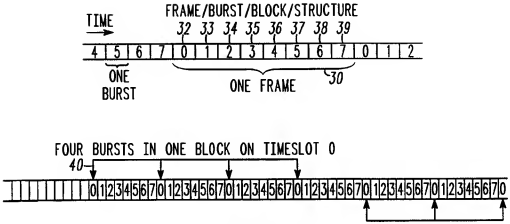

FIG.3

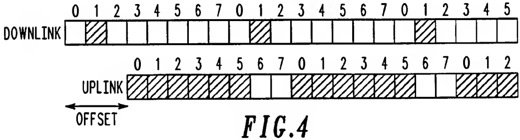

FIG.4

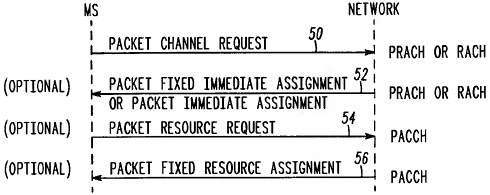

FIG.5

FRAME	BLOCK	SLOT #0 (MPDCH)	SLOT #1 (PDCH)	SLOT #2 (PDCH)	SLOT #3 (PDCH)	SLOT #4 (PDCH)	SLOT #5 (PDCH)	SLOT #6 (PDCH)	SLOT #7 (PDCH)
1000	B0	PRACH	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1004	B1	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1008	B2	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1013	B3	PRACH	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1017	B4	α	α	α	α	α	α	α	α
1021	B5	α	α	α	α	α	α	α	α
1026	B6	PRACH	α	α	α	α	α	α	α
1030	B7	α	α	α	α	α	α	α	α
1034	B8	α	α	α	α	α	α	α	α
1039	B9	PRACH	α	α	α	α	α	α	α
1043	B10	α	α	α	α	α	α	α	α
1047	B11	α	α	α	α	α	α	α	α
1052	B0	PRACH	α	α	α	OPEN	OPEN	OPEN	OPEN
1056	B1	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1060	B2	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1065	B3	PRACH	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1069	B4	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1073	B5	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN

FIG.6

b0= 1	b1= 1	b2= 1	b3= 1	b4= 1	b5= 1	b6= 1	b7= 1
b0= 1	b1= 1	b2= 1	b3= 1	b4= 1	b5= 1	b6= 1	b7= 1
b8= 1	b9= 1	b10= 1	b11= 1	b12= 1	b13= 1	b14= 1	b1= 1
b16= 0	b17= 1	b18= 1	b19= 1	b20= 1	b21= 1	b22= 1	b23= 1
b24= 1	b25= 1	b26= 1	b27= 1	b28= 1	b29= 1	b30= 1	b31= 1
b32= 1	b33= 1	b34= 1	b35= 1	b36= 1	b37= 1	b38= 1	b39= 1
b40= 0	b41= 1	b42= 1	b43= 1	b44= 1	b45= 1	b46= 1	b47= 1
b48= 1	b49= 1	b50= 1	b51= 1	b52= 1	b53= 1	b54= 1	b55= 1
b56= 1	b57= 1	b58= 1	b59= 1	b60= 1	b61= 1	b62= 1	b63= 1
b64= 0	b65= 1	b66= 1	b67= 1	b68= 0	b69= 0	b70= 0	b71= 0
b72= 0	b73= 0	b74= 0	b75= 0	b76= 0	b77= 0	b78= 0	b79= 0
b80= 0	b81= 0	b82= 0	b83= 0	b84= 0	b85= 0	b86= 0	b87= 0

FIG.7

FRAME	BLOCK	SLOT #0 (MPDCH)	SLOT #1 (PDCH)	SLOT #2 (PDCH)	SLOT #3 (PDCH)	SLOT #4 (PDCH)	SLOT #5 (PDCH)	SLOT #6 (PDCH)	SLOT #7 (PDCH)
1000	B0	PRACH	OPEN	b	OPEN	TCH	TCH	OPEN	c
1004	B1	OPEN	OPEN	b	OPEN	TCH	TCH	OPEN	c
1008	B2	OPEN	OPEN	b	OPEN	TCH	TCH	OPEN	c
1013	B3	PRACH	OPEN	b	OPEN	TCH	TCH	OPEN	c
1017	B4	a	a	b	a	TCH	TCH	a	c
1021	B5	a	a	b	a	TCH	TCH	a	c
1026	B6	PRACH	a	b	a	TCH	TCH	a	c
1030	B7	a	a	b	a	TCH	TCH	a	c
1034	B8	a	a	a	a	TCH	TCH	a	c
1039	B9	PRACH	a	a	a	TCH	TCH	a	c
1043	B10	a	a	a	a	TCH	TCH	a	c
1047	B11	a	a	a	a	TCH	TCH	a	a
1052	B0	PRACH	a	a	a	TCH	TCH	a	a
1056	B1	a	a	a	a	TCH	TCH	a	a
1060	B2	a	a	a	a	TCH	TCH	a	a
1065	B3	PRACH	a	a	a	TCH	TCH	a	a
1069	B4	a	a	a	a	TCH	TCH	a	a
1073	B5	a	a	OPEN	OPEN	TCH	TCH	OPEN	OREN

FIG.8

TIMESLOT ASSIGNMENT	b0= 1	b1= 1	b2= 1	b3= 1	b4= 0	b4= 0	b4= 1	b5= 1
	b0= 1	b1= 1	b2= 0	b3= 1			b4= 1	b5= 0
	b6= 1	b7= 1	b8= 0	b9= 1			b10= 1	b11= 0
	b12= 0	b13= 1	b14= 0	b15= 1			b16= 1	b17= 0
	b18= 1	b19= 1	b20= 0	b21= 1			b22= 1	b23= 0
BLOCK	b24= 1	b25= 1	b26= 1	b27= 1			b28= 1	b29= 0
ASSIGNMENT	b30= 0	b31= 1	b32= 1	b33= 1			b34= 1	b35= 0
BITMAP	b36= 1	b37= 1	b38= 1	b39= 1			b40= 1	b41= 1
	b42= 1	b43= 1	b44= 1	b45= 1			b46= 1	b47= 1
	b48= 0	b49= 1	b50= 1	b51= 0			b52= 1	b53= 1
	b54= 1	b55= 1	b56= 1	b57= 1			b58= 1	b59= 1
	b60= 1	b61= 1	b62= 1	b63= 1			b64= 1	b65= 1
	b66= 0	b67= 1	b68= 1	b69= 1			b70= 1	b71= 1
	b72= 1	b73= 1	b74= 1	b75= 1			b76= 1	b77= 1
	b78= 1	b79= 1	b80= 0	b81= 0			b82= 0	b83= 0
	b84= 0	b85= 0	b86= 0	b87= 0				

FIG.9

FIG.10

SLOT ASSIGNMENT	bo= 1	b1= 1	b2= 1	b3= 1	b4= 1	b5= 1	b6= 1	b7= 1
BURST ASSIGNMENT	bo= 1	b1= 1	b2= 1	b3= 1	b4= 1	b5= 1	b6= 1	b7= 1
	b8= 0	b9= 1	b10= 1	b11= 1	b12= 1	b13= 1	b14= 1	b15= 0
	b16= 1	b17= 1	b18= 1	b19= 1	b20= 1	b21= 1	b22= 1	b23= 1
	b24= 1	b25= 1	b26= 1	b27= 1	b28= 1	b29= 1	b30= 1	b31= 0
	b32= 0	b33= 1	b34= 1	b35= 1	b36= 1	b37= 1	b38= 1	b39= 1
	b40= 1	b41= 1	b42= 1	b43= 1	b44= 1	b45= 1	b46= 1	b47= 0
	b48= 1	b49= 1	b50= 1	b51= 1	b52= 1	b53= 1	b54= 1	b55= 1
	b56= 0	b57= 1	b58= 1	b59= 1	b60= 1	b61= 1	b62= 1	b63= 0
	b64= 0	b65= 1	b66= 1	b67= 1	b68= 1	b69= 1	b70= 1	b71= 1
	b72= 1	b73= 1	b74= 1	b75= 1	b76= 1	b77= 1	b78= 1	b79= 0
	b80= 0	b81= 0	b82= 0	b83= 1	b84= 0	b85= 1	b86= 0	b87= 0

FRAME	MULTI-FRAME	SLOT #0 (MPDCH)	SLOT #1 (PDCH)	SLOT #2 (PDCH)	SLOT #3 (PDCH)	SLOT #4 (PDCH)	SLOT #5 (PDCH)	SLOT #6 (PDCH)	SLOT #7 (PDCH)
1000	B0		OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1004	B1		OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1008	B2	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1013	B3		OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1017	B4	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1021	B5	a	a	a	a	a	a	a	a
1026	B6		a	a	a	a	a	OPEN	OPEN
1030	B7	b	b	b	b	b	b	b	b
1034	B8	b	b	b	b	b	b	b	b
1039	B9		b	b	b	b	b	b	b
1043	B10	b	b	b	b	b	b	b	b
1047	B11	b	b	b	b	b	b	b	b
1052	B0		b	b	b	b	b	b	b
1056	B1		b	b	b	b	b	b	b
1060	B2	b	b	b	b	b	b	b	b
1065	B3		b	b	b	b	b	a	a
1069	B4	a	a	a	a	a	a	a	a
1073	B5	a	a	a	a	a	a	OPEN	OPEN
1078	B6		a	a	a	a	a	a	a
1082	B7	a	a	a	a	a	a	OPEN	OPEN
1086	B8	a	a	a	a	a	a	a	a
1091	B9		a	a	a	a	a	OPEN	OPEN
1095	B10	a	a	a	a	a	a	a	a
1099	B11	a	a	a	OPEN	OPEN	OPEN	OPEN	OPEN

OPEN	PRACH	DL ACK	A	B	C	D	E	F	G
50	10	0	66	66	0	0	0	0	0
26.04%	5.21%	0.00%	34.38%	34.38	0.00%	0.00%	0.00%	0.00%	0.00%

FIG.11

FRAME	MULTI-FRAME	SLOT #0 (MPDCH)	SLOT #1 (PDCH)	SLOT #2 (PDCH)	SLOT #3 (PDCH)	SLOT #4 (PDCH)	SLOT #5 (PDCH)	SLOT #6 (PDCH)	SLOT #7 (PDCH)
1000	B0		OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1004	B1		OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1008	B2	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1013	B3		OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1017	B4	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1021	B5	a	a	a	a	a	a	OPEN	a
1026	B6		a	a	a	a	a	a	OPEN
1030	B7	OPEN	a	a	a	a	a	a	a
1034	B8	a	OPEN	a	a	a	a	a	a
1039	B9		a	OPEN	a	a	a	a	a
1043	B10	a	a	a	OPEN	a	a	a	a
1047	B11	a	a	a	a	OPEN	a	a	a
1052	B0		a	a	a	a	OPEN	a	a
1056	B1		a	a	a	a	a	OPEN	a
1060	B2		a	a	a	a	a	a	OPEN
1065	B3		a	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1069	B4	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1073	B5	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1078	B6		OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1082	B7	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1086	B8	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1091	B9		OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1095	B10	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1099	B11	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN

OPEN	PRACH	DL ACK	A	B	C	D	E	F	G
115	10	0	66	0	0	0	0	0	0
59.90%	5.21%	0.00%	34.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

FIG.12

FIG.13

SLOT ASSIGNMENT	bo= 1	b1= 1	b2= 1	b3= 1	b4= 1	b5= 1	b6= 1	b7= 1
BURST ASSIGNMENT	bo= 1	b1= 1	b2= 1	b3= 1	b4= 1	b5= 1	b6= 0	b7= 1
	b8= 0	b9= 1	b10= 1	b11= 1	b12= 1	b13= 1	b14= 1	b15= 0
	b16= 0	b17= 1	b18= 1	b119= 1	b20= 1	b21= 1	b22= 1	b23= 1
	b24= 1	b25= 0	b26= 1	b27= 1	b28= 1	b29= 1	b30= 1	b31= 0
	b32= 0	b33= 1	b34= 0	b35= 1	b36= 1	b37= 1	b38= 1	b39= 1
	b40= 1	b41= 1	b42= 1	b43= 0	b44= 1	b45= 1	b46= 1	b47= 0
	b48= 1	b49= 1	b50= 1	b51= 1	b52= 0	b53= 1	b54= 1	b55= 1
	b56= 0	b57= 1	b58= 1	b59= 1	b60= 1	b61= 0	b62= 1	b63= 1
	b64= 0	b65= 1	b66= 1	b67= 1	b68= 1	b69= 1	b70= 0	b71= 1
	b72= 1	b73= 1	b74= 1	b75= 1	b76= 1	b77= 1	b78= 1	b79= 0
	b80= 0	b81= 1	b82= 0	b83= 0	b84= 0	b85= 0	b86= 0	b87= 0

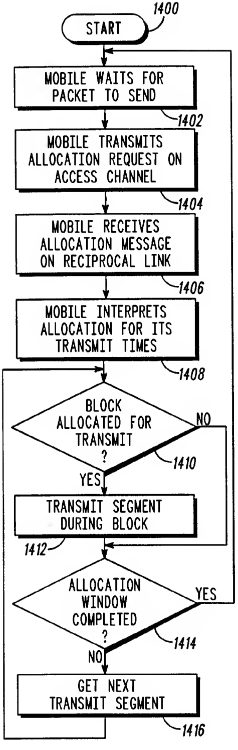
1400
START
MOBILE WAITS FOR PACKET TO SEND
1402
MOBILE TRANSMITS ALLOCATION REQUEST ON ACCESS CHANNEL
1404
MOBILE RECEIVES ALLOCATION MESSAGE ON RECIPROCAL LINK
1406
MOBILE INTERPRETS ALLOCATION FOR ITS TRANSMIT TIMES
1408
BLOCK ALLOCATED FOR TRANSMIT ?
NO
1410
YES
TRANSMIT SEGMENT DURING BLOCK
1412
ALLOCATION WINDOW COMPLETED ?
YES
1414
NO
GET NEXT TRANSMIT SEGMENT
1416

FIG.14

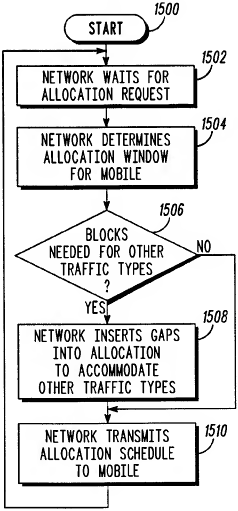
1500
START
1502
NETWORK WAITS FOR ALLOCATION REQUEST
1504
NETWORK DETERMINES ALLOCATION WINDOW FOR MOBILE
1506
BLOCKS NEEDED FOR OTHER TRAFFIC TYPES ?
NO
YES
1508
NETWORK INSERTS GAPS INTO ALLOCATION TO ACCOMMODATE OTHER TRAFFIC TYPES
1510
NETWORK TRANSMITS ALLOCATION SCHEDULE TO MOBILE

FIG.15

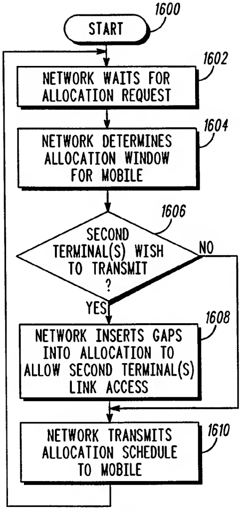
1600
START
1602
NETWORK WAITS FOR ALLOCATION REQUEST
1604
NETWORK DETERMINES ALLOCATION WINDOW FOR MOBILE
1606
SECOND TERMINAL(S) WISH TO TRANSMIT ?
NO
YES
1608
NETWORK INSERTS GAPS INTO ALLOCATION TO ALLOW SECOND TERMINAL(S) LINK ACCESS
1610
NETWORK TRANSMITS ALLOCATION SCHEDULE TO MOBILE

FIG.16

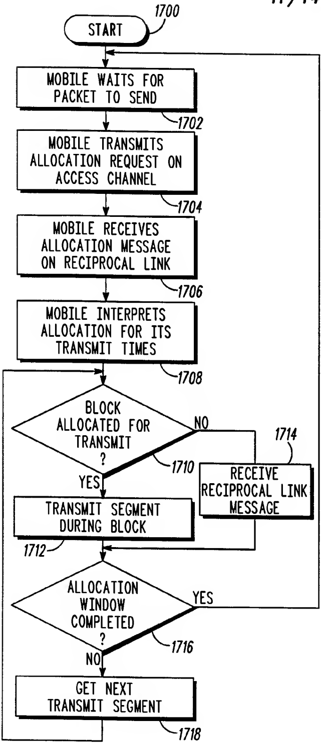
1700
START
MOBILE WAITS FOR PACKET TO SEND
1702
MOBILE TRANSMITS ALLOCATION REQUEST ON ACCESS CHANNEL
1704
MOBILE RECEIVES ALLOCATION MESSAGE ON RECIPROCAL LINK
1706
MOBILE INTERPRETS ALLOCATION FOR ITS TRANSMIT TIMES
1708
BLOCK ALLOCATED FOR TRANSMIT ?
NO
YES
1710
1714
RECEIVE RECIPROCAL LINK MESSAGE
TRANSMIT SEGMENT DURING BLOCK
1712
ALLOCATION WINDOW COMPLETED ?
YES
NO
1716
GET NEXT TRANSMIT SEGMENT
1718

FIG.17

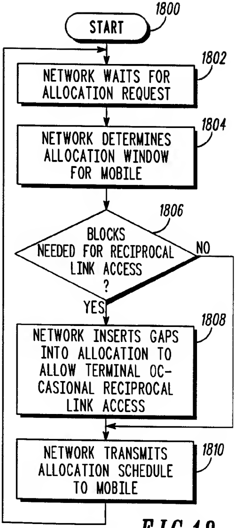
1800
START
1802
NETWORK WAITS FOR ALLOCATION REQUEST
1804
NETWORK DETERMINES ALLOCATION WINDOW FOR MOBILE
1806
BLOCKS NEEDED FOR RECIPROCAL LINK ACCESS ?
NO
YES
1808
NETWORK INSERTS GAPS INTO ALLOCATION TO ALLOW TERMINAL OC-CASIONAL RECIPROCAL LINK ACCESS
1810
NETWORK TRANSMITS ALLOCATION SCHEDULE TO MOBILE

FIG.18

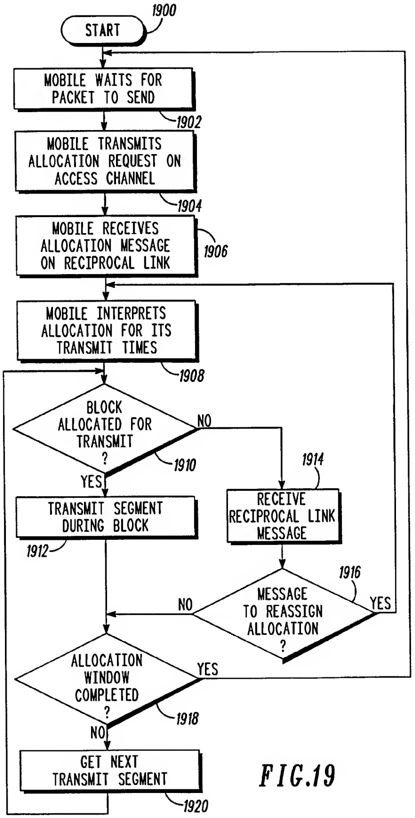
1900
START
MOBILE WAITS FOR PACKET TO SEND
1902
MOBILE TRANSMITS ALLOCATION REQUEST ON ACCESS CHANNEL
1904
MOBILE RECEIVES ALLOCATION MESSAGE ON RECIPROCAL LINK
1906
MOBILE INTERPRETS ALLOCATION FOR ITS TRANSMIT TIMES
1908
BLOCK ALLOCATED FOR TRANSMIT ?
1910
NO
YES
TRANSMIT SEGMENT DURING BLOCK
1912
1914
RECEIVE RECIPROCAL LINK MESSAGE
1916
MESSAGE TO REASSIGN ALLOCATION ?
NO
YES
ALLOCATION WINDOW COMPLETED ?
1918
YES
NO
GET NEXT TRANSMIT SEGMENT
1920

FIG.19

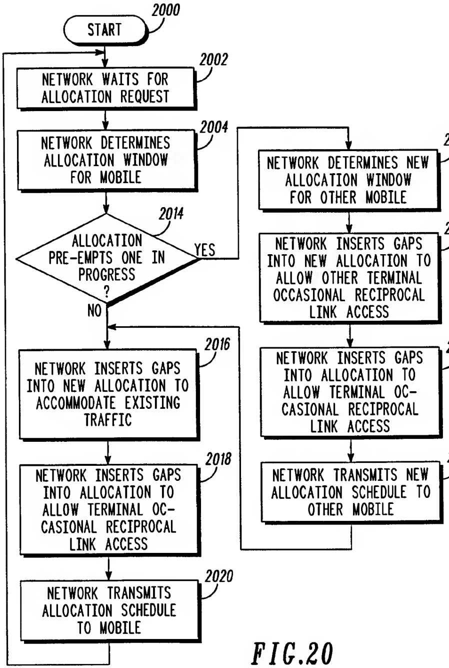
2000
START
2002
NETWORK WAITS FOR ALLOCATION REQUEST
2004
NETWORK DETERMINES ALLOCATION WINDOW FOR MOBILE
2014
ALLOCATION PRE-EMPTS ONE IN PROGRESS ?
YES
NO
2006
NETWORK DETERMINES NEW ALLOCATION WINDOW FOR OTHER MOBILE
2008
NETWORK INSERTS GAPS INTO NEW ALLOCATION TO ALLOW OTHER TERMINAL OCCASIONAL RECIPROCAL LINK ACCESS
2010
NETWORK INSERTS GAPS INTO ALLOCATION TO ALLOW TERMINAL OC-CASIONAL RECIPROCAL LINK ACCESS
2012
NETWORK TRANSMITS NEW ALLOCATION SCHEDULE TO OTHER MOBILE
2016
NETWORK INSERTS GAPS INTO NEW ALLOCATION TO ACCOMMODATE EXISTING TRAFFIC
2018
NETWORK INSERTS GAPS INTO ALLOCATION TO ALLOW TERMINAL OC-CASIONAL RECIPROCAL LINK ACCESS
2020
NETWORK TRANSMITS ALLOCATION SCHEDULE TO MOBILE

FIG.20

FRAME	MULTI-FRAME	SLOT #0 (MPDCH)	SLOT #1 (PDCH)	SLOT #2 (PDCH)	SLOT #3 (PDCH)	SLOT #4 (PDCH)	SLOT #5 (PDCH)	SLOT #6 (PDCH)	SLOT #7 (PDCH)
1000	B0	PRACH	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1004	B1	PRACH	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1008	B2	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1013	B3	PRACH	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1017	B4	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1021	B5	a	a	a	a	a	a	a	a
1026	B6	PRACH	a	a	a	a	a	OPEN	OPEN
1030	B7	a	a	a	a	a	a	a	a
1034	B8	a	a	a	a	a	a	OPEN	OPEN
1039	B9	PRACH	a	a	a	a	a	a	a
1043	B10	a	a	a	a	a	a	OPEN	OPEN
1047	B11	a	a	a	a	a	a	a	a
1052	B0	PRACH	a	a	a	a	a	OPEN	OPEN
1056	B1	PRACH	a	a	a	a	a	a	a
1060	B2	a	a	a	a	a	a	OPEN	OPEN
1060	B3	PRACH	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1064	B4	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
1068	B5	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN

FIG.21